

Listing of Claims

1. (original) A gaseous fuel supply apparatus with a shut-off valve, which supplies gaseous fuel from a gaseous fuel tank storing gaseous fuel to a gaseous fuel combustion engine using gaseous fuel, comprising:

a gaseous fuel flow unit which is communicated with the gaseous fuel tank and the gaseous fuel combustion engine and flows gaseous fuel between the gaseous fuel tank and the gaseous fuel combustion engine;

a shut-off valve which is provided in the gaseous fuel flow unit and selectively opens or closes a flow of the gaseous fuel in the gaseous fuel flow unit; and

a gaseous fuel charge unit which is provided in the gaseous fuel flow unit between the gaseous fuel combustion engine and the shut-off valve and is used to charge the gaseous fuel from an outside into the gaseous fuel flow unit,

the shut-off valve comprising:

a valve housing which includes a first connection port connected to a first part of the gaseous fuel flow unit, the first part being close to the gaseous fuel tank, a second connection port connected to a second part of the gaseous fuel flow unit, the second part being close to the gaseous fuel engine and the gaseous fuel charge unit, and a valve chest provided between the first connection port and the second connection port and having a valve port communicating the first and second connection ports with each other;

a seal member which surrounds the valve port on an inner surface of the valve chest of the valve housing;

a valve member which is provided in the valve housing and is movable between a closed position and an open position, at the closed position the valve member being in contact with the seal member and closing the valve port of the valve chest and at the

open position the valve member separating from the seal member and opening the valve port of the valve chest; and

a valve member drive unit which drives the valve member by an electromagnetic force.

2. (original) A gaseous fuel supply apparatus according to claim 1, wherein a circular projection is provided on a part of the valve member of the shut-off valve, the part contacting and separating from the seal member, and the circular projection surrounds the valve port of the valve chest in the valve housing while the circular projection is in contact with the seal member.

3. (original) A gaseous fuel supply apparatus according to claim 1, wherein the shut-off valve further comprises a circular seal member support block which is formed independently of the valve housing, surrounds the valve port on the inside surface of the valve chest in the valve housing, and supports the seal member.

4. (original) A gaseous fuel supply apparatus according to claim 3, wherein the seal member support block has a circular groove in which the seal member is provided.

5. (original) A gaseous fuel supply apparatus according to claim 1, wherein a filter is provided in at least one of the first connection port and second connection ports in the valve housing, and catches foreign materials contained in the gaseous fuel passing through the ports.

6. (original) A gaseous fuel supply apparatus according to claim 1, wherein

the valve drive unit includes a plunger-solenoid assembly,

and the valve member is connected to one end portion of the plunger of the assembly to be movable with respect to the plunger in a predetermined distance along the moving direction of the plunger;

only the plunger moves without separating the valve member from the seal member of the valve chest in the valve housing, in an initial step before one end portion of the plunger moves in the predetermined distance with respect to the valve member while the plunger moves in a direction being away from the seal member of the valve chest; and

the plunger moves together with the valve member and separates the valve member from the seal member of the valve chest in the valve housing, in a step after" the one end portion of the plunger moves in the predetermined distance with respect to the valve member in the direction being, away from the seal member.

7. (original) A gaseous fuel supply apparatus according to claim 6, wherein

the plunger-solenoid assembly includes two types of solenoid coils, and an urging element which urges the plunger toward the seal member of the valve chest in the valve housing and presses the valve member on the seal member while the two solenoid coils are not applied with electric current;

one of the two solenoid coils is applied with electric current to drive the valve member from the closed position toward the open position, so that a force which is larger than a total of a force generated by a pressure difference between the gaseous fuel in the first connection port and that in the second connection port in the valve housing and holds the valve member in the closed position and an urging force of the urging element applied on the valve member, is applied on the plunger to drive

the valve member from the closed position to the open position; and

both of the solenoid coils are applied with electric current while the valve member is arranged in the open position, so that a force larger than the urging force applied on the valve member by the urging element is applied on the plunger to hold the valve member in the open position against the urging force.

8. (original) A gaseous fuel supply apparatus according to claim 6, wherein

a communication hole is provided in the valve member, the communication hole having both ends one of which is opened at one part of the outside surface of the valve member and another of which is opened at another part of the outside surface of the valve member, the one part facing the valve port of the valve chest in the valve housing while the valve member is arranged at the closed position, and the another part facing the end of the one end portion of the plunger;

an auxiliary seal member is provided at the end of the one end portion of the plunger;

the auxiliary seal member closes the opening of the communication hole at the plunger facing part of the valve member while the two-types of solenoid coils are not excited and the plunger holds the valve member at the closed position by the urging force of the urging member, and separates from the opening of the communication hole at the plunger facing part of the valve member when the plunger starts to move with respect to the valve member in the initial step while the valve member moves from the closed position to the open position;

a concave is formed in the end of the one end portion of the plunger, to hold the auxiliary seal member, and

a communication structure is provided in at least one of the

inside surface of the concave and a region of the outside surface of the auxiliary seal member, the region facing the inside surface of the concave, and the communication structure communicates a clearance between the inside surface of the concave and the inside surface facing region of the outside surface of the auxiliary seal member, to a clearance between the end of the one end portion of the plunger and the plunger facing part of the valve member; and

the clearance between the end of the one end of the plunger and the plunger facing part of the valve member communicates with one side of the valve port in the valve chest in the valve housing, the one side communicating with the first commutation port.

9. (original) A gaseous fuel supply apparatus according to claim 8, wherein the communication structure is at least one groove formed in the inside surface facing region of the outside surface of the auxiliary sealing member.

10. (original) A gaseous fuel supply apparatus according to claim 8, wherein

the plunger facing part of the valve member has a circular projection surrounding the opening of the communication port in the plunger facing part and projecting toward the end of the one end portion of the plunger; and

the projected end of the circular projection on the plunger facing part of the valve member is in contact with the auxiliary seal member while the auxiliary seal member at the end of the one end portion of the plunger closes the opening of the communication hole at the plunger facing part of the valve member.